FREEWAT

Free and Open Source Software Tools for Water Resource Management

EU HORIZON 2020 Project

Policy Brief N. 6/7

# FREEWAT for Water Resource Management in rural areas

## *Key Policy Messages*

- ✓ Digital tools may help in solving issues in rural water management
- ✓ A FREEWAT-based simulation approach was adopted to devise new land and water management practices in rural areas
- ✓ Simulation scenarios supported decision makers in understanding the effects of new strategies

## WHAT H2020 FREEWAT is

FREEWAT is an HORIZON 2020 project financed by the EU Commission, aiming at promoting water resource management through innovative ICT tools and participatory approach.

Main result of the project is the free and open-source FREEWAT software: a QGIS integrated environment, where several simulation codes, based on the hydrological cycle, hydrochemical or economic-social processes, are integrated in a unique GIS project for conjunctive use of surface- & ground-water.

This Policy Brief is part of series of seven whose goal is to illustrate the FREEWAT approach and achievements.

European Commission

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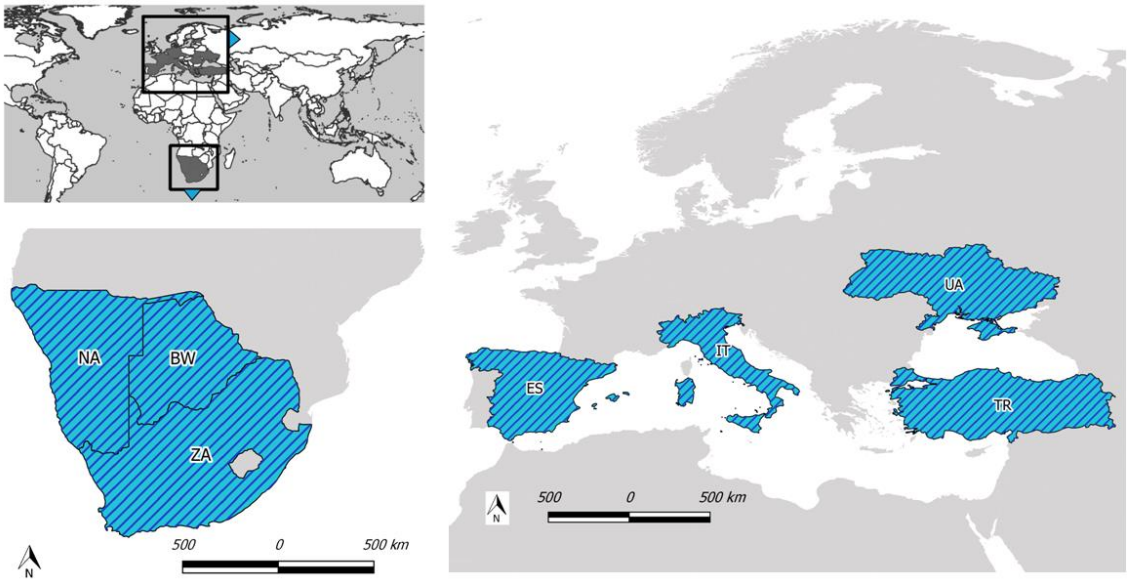
## Digital tools may help in solving issues in rural water management

During the last decades, the freshwater resource has been facing growing pressure, due to both human impacts and climate changes. This holds especially true in the rural environment, where the bulk of water abstraction takes place. However, it must be noticed that lower attention is paid to strategies for water resource management in the rural sector than in any other (i.e., "smart cities"). Conjunctive use of ground- and surface-water in agriculture is of outmost importance in many rural areas of Europe. The EU Nitrates Directive aims at preventing nitrates pollution of freshwater from agricultural sources and at promoting the adoption of good farming practices. Member States are required to monitor and to set in operation prevention practices in local Action Programs. Stakeholders and partners involved in water resource management within the FREEWAT project confirmed that water management in rural areas is a major priority for which new software tools for assessing the impact of agricultural activities on ground- and surface-water are needed (see Policy Brief 1/7). Proper water resource management and planning is thus of paramount importance and smart management of conjunctive use of ground- and surface-water is needed, in order to detect and eventually restore critical situations. In this view, GIS-integrated simulation environments may provide reliable tools in order to evaluate phenomena in space and time and to get insights into water-constrained agricultural production.

In the framework of rural water management, tools for simulating optimization of ground- and surface-water have been integrated in FREEWAT.

Well-tested and relatively easy-to-use tools to deal with all of these aspects and to raise awareness on the importance of rural water management have been made available to the scientific and professional community. Such tools were tested and applied to five case studies, in EU and Africa (Italy, Spain, Ukraine, Turkey, Namibia, Botswana and South Africa).

*Inefficient irrigation in horticultural crops in Italy.*




*FREEWAT case studies devoted to water resource management in rural areas.*

## A FREEWAT-based simulation approach was adopted to devise new land and water management practices in rural areas

The aim of applying the FREEWAT platform to case studies devoted to rural water management is to adopt a simulation-based approach to evaluate (i) the effectiveness of practices to reduce nitrate pollution in Nitrate Vulnerable Zones (NVZs); (ii) new land and water management schemes; (iii) long–term sustainability of water uses.

Diffuse nitrates pollution of water resource is the main issue in the ***Tudela-Cortes*** NVZ (Navarra, Spain). The objective of this case study is to set up a modeling-based approach to estimate reliability and effectiveness of setting measures to reduce nitrate loads to groundwater in order to fulfill the Nitrates Directive requirements.

The major limiting factor for crop productivity in the ***Bakumivka River Catchment*** (northern Ukraine) is the water regime, which is subject to extreme variations in space and time, resulting in extremely wet-to-dry conditions. The need to regulate this issue lead to build a drainage-irrigation system in 1968-69, which resulted in change of land cover patterns, crop composition and related agro-technologies used. As the drainage-irrigation system is currently unsuitable to support traditional agriculture, different land cover scenarios were simulated to conjunctively manage the water and the soil resource.

The ***Massaciuccoli Lake Basin*** (central Italy) is a coastal lacustrine area largely drained by 1930 for agriculture purposes. Since land reclamation activities started, the area suffered land subsidence, water salinization and eutrophication, and severe water stress conditions, especially in the dry season. A new land management strategy, based on groundwater head levels need to be accepted leading to rewetting of today's drained areas.

*Occurrence of a sinkhole depression in the STAS area.*

Overexploitation of freshwater resources for irrigation purposes is a major concern in the ***Palas Basin*** (central Anatolia, Turkey), a semi-arid closed basin where agriculture represents the main economic activity. Here, the intensive use of ground- and surface-water resources threatens the sustainability of the Tuzla lake ecosystem. As such, understanding the relationships between agricultural water uses and natural water flows to the Tuzla lake is a major issue for long-term water management in the area.

The modeling-based approach has also been adopted to foster the establishment of a multi-country cooperation mechanism among governments of Namibia, Botswana and South-Africa for managing the ***Stampriet Transboundary Aquifer System*** (STAS). The STAS is the only permanent source of freshwater for drinking and irrigation uses in the area. Scarcity of data on large areas characterized its application. The modeling activities have been devoted to produce a shared model which helps in harmonizing existing databases, improving understanding the STAS hydrodynamics, and identifying existing gaps.

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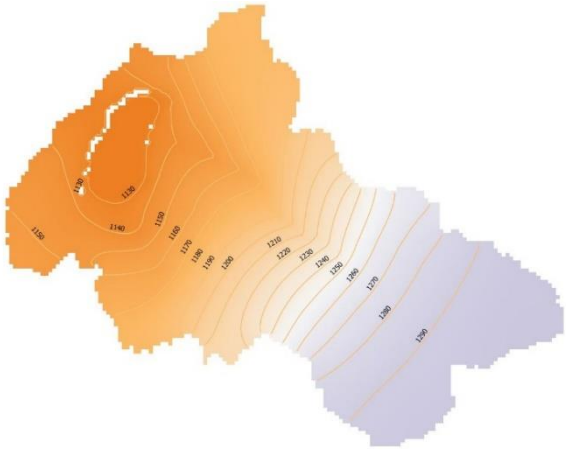
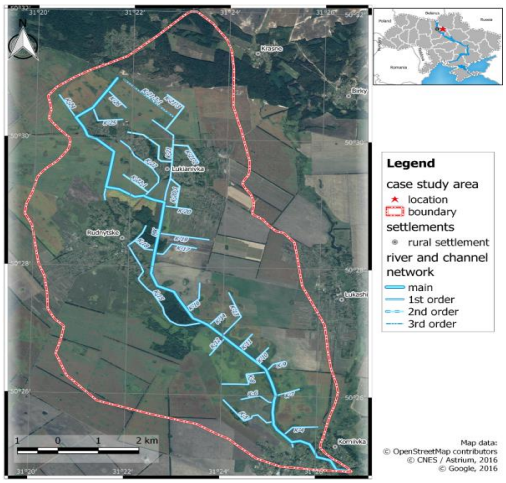
# Simulation scenarios supported decision makers in understanding the effects of new strategies

The modeling-based approach aimed at supporting decision makers in designing measures to be included in Action Programmes, as instructed by the EU Nitrates Directive, as well as to evaluate the reliability of measures foreseen in the WFD for rural management.
Water management scenarios were modeled to analyze the response of hydrosystems to different agricultural practices and land use conditions. Results of three of the above-mentioned case studies are presented.
Different groundwater abstraction rates were inputted to design scenarios at ***Palas Basin*** (Turkey), in order to understand how aquifer exploitation affects the lake hydrology. Water flows to the Tuzla lake resulted to be significantly related to pumping rates. As an example, a complete stop of groundwater pumping would increase discharge to the Tuzla Lake by 0.61 $Mm^3/y$. Furthermore, a raise of 0.46 m of the average lake level would be recorded. On the other hand, increasing groundwater pumping by 50% with respect to the reference situation would make discharge to the Tuzla lake to decrease by 0.31 $Mm^3/y$, while the average lake stage would drop 0.31 m lower than that recorded at the current condition.



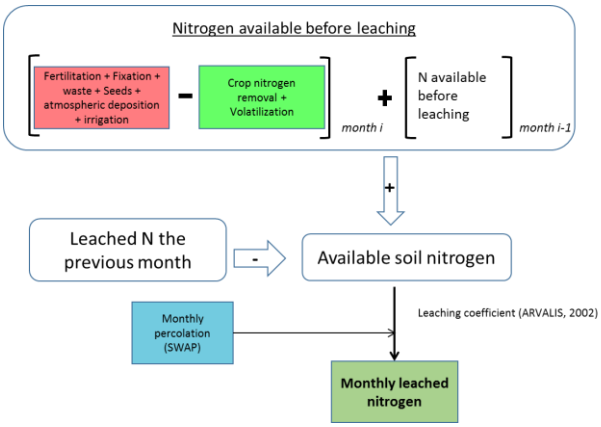
*Groundwater levels simulated at Palas Basin under reference conditions.*

Spatial pattern of land cover is essential in water management within the ***Bakumivka River Basin*** (Ukraine). Three water management scenarios were simulated, in order to compare different spatial patterns of land cover and water distribution. Scenarios were set assuming that: (i) crops are those used in the last five years in forest-steppe zones Ukraine, (ii) 70% of the arable lands are occupied by the most economically profitable crops, (iii) organization of landscape is compliant with the principles of landscape ecological planning. Maps identifying areas with optimal water balance for specific crops were produced, based on the difference between the simulated water head and the optimal water head laying within the active root zone.




*Location of the Bakumivka River Basin.*

Water management scenarios in ***Tudela-Cortes*** (Spain) were devoted to evaluate measures foreseen in the Agronomic Action Programme for reducing fertilization doses. The following scenarios were simulated: (i) hypothetical abandonment of agricultural activity, with crops replaced by non-irrigated pasture; (ii) reduction of the applied fertilization doses by 10%; (iii) improving efficiency of the irrigation systems, to evaluate the contribution of reducing irrigation water on nitrogen leaching. Besides the abandonment scenario is the only that would effectively reduce nitrate concentration in the short-medium term, reducing fertilization is the most suitable measure.




*Methodology adopted to simulate nitrate leaching.*

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